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Identifying key factors for mobilising under-utilised low carbon land resources: A case study on Kalimantan

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ABSTRACT

Mobilising under-utilised low carbon (ULC) land for future agricultural expansion helps minimising further carbon stock loss. This study examined the regency cases in Kalimantan, a carbon loss hotspot, to understand the key factors for mobilising ULC land via narrative interviews with a range of land-use actors and complementary desktop analyses. The factors were broadly categorised into economic, agro-ecological, institutional and cultural factors, which were perceived as opportunities and/or barriers by different land-uses and stakeholders (with different business models), and can vary across regencies. Generally, oil palm was regarded by most interviewees as an economic opportunity, reflecting that there were no other more attractive options. However, oil palm may also be limited by various factors. For example, labour availability may greatly limit the actual amount of land that can be mobilised in many regencies due to low population density. These economic factors were interlinked with the agro-ecological factors, such as soil quality, which was often regarded as the reason of low economic attractiveness. The other two categories, institutional and cultural factors, are more subtle and complex, involving socio-political elements across the hierarchy of authorities. Understanding these factors requires understanding the relationships between different stakeholders and their histories. Past analyses on ULC land largely focus on a single crop or end-use. This study shows that mobilisation of ULC land has to depart from analysing the specific conditions within individual regencies, especially considering the views of multiple land-use actors on different land-use options and business models. Future research is recommended to assess available land-use options and business models by investigating how they are affected by each of the factors identified here and accounting for the policy targets set by individual regencies (e.g. economic development or food security) and the preference and capability of local actors.

1. Introduction

Rapid land-use change (LUC), particularly deforestation and conversion of peatland, in Kalimantan (Indonesia) has led to many environmental problems in the past decades (see e.g. Moore et al., 2013; Tacconi et al., 2008). One of the most serious problems is the substantial loss of carbon stock from deforestation as well as peat degradation, drainage and burning which have significantly contributed to global greenhouse gas emissions and climate change, and led to health-threatening transboundary haze. Annual carbon stock loss in Kalimantan contributed to roughly 30% of the total carbon stock loss of Indonesia, ranging from 0.3 to 0.6 billion tonne CO_2 per year (Abood et al., 2015). Agricultural expansion due to increasing demand, especially for export-oriented oil palm plantation, is recognised as one of the major culprits (Agus et al., 2013; Austin et al., 2015; Wicke et al., 2011). In 2011, the total area planted with oil palm in Kalimantan increased to about 3 Mha, and half of this area involved direct conversion of upland forest and wetland (Gunarso et al., 2013). Since then, the oil palm area has increased to 3.5 Mha in 2014 (DG Estate Crops Indonesia, 2013).

As global demand for palm oil is expected to grow further in the future (FAOSTAT, 2016; OECD/FAO, 2016), it is necessary to ensure that future agricultural production, especially palm oil, does not cause further carbon stock loss. Overall, these aims can be translated into two basic criteria when searching for potential land resources for future agricultural activities: (i) the current agricultural productivity of the land is insignificant or low compared to its optimal potential (i.e. there is significant room for more production per unit land); and (ii) the level of carbon stock is low so that land utilisation is unlikely to incur additional carbon stock loss and negative ecological impacts (e.g. forest

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and wetland must be excluded). Such land may be broadly regarded as under-utilised[1] low carbon (ULC) land.[2]

Various studies have tried to quantify the physical area of ULC land using environmental criteria (especially in terms of carbon stocks) and agro-ecological criteria (in terms of land suitability for certain crops) at national, regional or provincial level (e.g. Hadian et al., 2014; Gingold et al., 2012). The analyses were performed for a specific crop (particularly oil palm, e.g. Gingold et al., 2012) or a specific end-use (particularly bioenergy, e.g. Hadian et al., 2014), but rarely linked this to the agrarian transformation in socio-economic aspect that involves different crops and actors across multiple sectors. Recent work by van der Laan et al. (2016) has demonstrated an integrated approach that also accounts for yield and supply chain improvements to assess the technical land potential for future agricultural production covering a range of crops. However, this study did not connect physical land availability and suitability to socio-economic conditions. But in reality, a wide range of socio-economic factors, e.g. labour availability and local preferences (Baumann et al., 2011), largely define whether ULC land can actually be mobilised[3] for additional agricultural production or not. For example, the study by Pirker et al. (2016) represents state-of-the-art quantitative analysis of potential future oil palm expansion, yet socio-economic factors are not incorporated.

The various socio-economic factors influencing the availability of ULC land may be perceived as either opportunities or barriers to mobilising ULC land depending on the actor (e.g. private company, farmers, local communities, government officials), their land-use preferences (e.g. mixed crop farming or monoculture oil palm) and business models (e.g. small-scale farming or industrial plantation). The viewpoints may also change from global, national to local level. For example, local land-users may see local labour shortage as a major barrier for intensification, while large-scale players may see it as an advantage in obtaining land-use permit with less land conflicts with local communities (Byerlee and Rueda, 2015). Many qualitative and narrative studies have investigated the relationship between land-use and socio-economic transformation in Kalimantan and Indonesia, e.g. Casson (2006); Potter (2011) and McCarthy (2013). However, they are not explicitly designed to identify ULC land, and evidence only exists either in the form of individual case studies (e.g. Tomich et al., 1997) or at a more aggregated level with a broader scope beyond ULC land (e.g. Shantiko et al., 2013; Gatto et al., 2015).

Our previous work assessed ULC land resources by reconciling information available from different sources, but have not specifically examined the individual factors that affect the mobilisation of these land resources (Goh et al., 2017). Based on these shortcomings, this study aims to identify the actual factors for mobilising ULC land resources, including not only agro-ecological factors, but also economic, institutional and cultural factors. To achieve the aim of the study, information and opinions were collected from actors involved in land-use and assessed for differences and similarities in what factors were seen as opportunities and barriers by the different actors. This is especially crucial to be performed within a relevant administrative level, i.e. the regency level, at which the authorities are the most influential in the actual implementation of land-use policies in Kalimantan. The detailed research sites were selected in Central Kalimantan, covering four regencies with distinctive characteristics. In addition, an important factor identified through the narrative interviews, i.e. labour availability, was further quantitatively investigated. This part was applied to all the regencies in Kalimantan. Extra attention was given to oil palm as a predominant land-use that has experienced rapid expansion in the past decades in Kalimantan, but other land-use options such as paddy and other permanent crops are also discussed.

2. Materials and methods

2.1. Obtaining viewpoints from land-use actors through narrative interviews

Narrative interviews were conducted to obtain positions and perspectives from different land-use actors on two research questions: (a) what are the key factors in mobilising ULC land from local and industrial perspectives, and (b) how do these affect the mobilisation of ULC land. Four regencies (names in italic) with distinctive characteristics were selected as case studies (Fig. 1), which broadly represent the following cases:

(i) Subsistence farming with alternative income sources – *Gunung Mas*. The regency is mainly occupied by subsistence farmers who did not undergo agricultural modernisation but have developed alternative income sources, i.e. small-scale (illegal) mining activities.
(ii) Integration with international market – *Kotawaringin Timur*. The regency, which has access to ports, has been rapidly developing intensive export-oriented agricultural activities, particularly industrial-scale oil palm plantations.
(iii) Urbanisation – *Palangka Raya*. The capital of Central Kalimantan is a suitable example to assess the impact of urbanisation on surrounding land-use.[4]
(iv) Unsuitable agro-ecological conditions – *Pulang Pisau*. The regency has a limited area suitable for agricultural activities due to unfavourable agro-ecological conditions (it is largely covered with swamp and peatlands). Nevertheless, its land-use patterns have been greatly influenced by policy intervention – it is the former site of the Mega Rice Project (MRP)[5] with a large influx of transmigrants.[6]

The field study was conducted by the first author, with the help of a small local team, between November 2014 and January 2015 in these four regencies. The potential sites (those with potentially low carbon land covers and likely under-utilised, like dry-field grass and shrub land) were screened based on the publicly available land cover maps (MoF, 2015). Then, the data collection started with short surveys with the local communities to identify places to visit and people to meet. Decisions were also made with consideration of logistical constraints. The targeted groups for interviews and discussions were local communities in the four regencies (Table S1). In addition, industrial perspectives were also examined through interviews with key industrial informants who have experience with oil palm establishment in Kalimantan (Table S2). Government officers, experts and scientists were also consulted for their views on land-use issues in relation to ULC land in the four regencies. A few key questions were formulated (see Table 1) to kick-start the discussion, but the interviews (mostly in the form of group discussions) were conducted in a flexible way to avoid preconception and allow unexpected hypotheses to emerge. The team was

[1] 'Under-utilised' is a normative notion that can be interpreted in different ways depending on e.g. socio-cultural values, economic values or legal perspectives. In this paper, it only refers to agricultural productivity to reflect criterion (i).

[2] We avoid the use of the term 'agriculture land' because it can be defined differently. For example, low carbon grass land within the forest concession is not legally considered as 'agriculture land'.

[3] 'Mobilisation' means actions of preparing and putting into active service, making it available, improving and coordinating its uses.

[4] Municipalities are usually small in area. Palangka Raya is considered a special case as a municipality with a relatively large area allocated. This situation allows the examination of how urbanisation affects LUC based on the LUC statistics at municipal level. For municipalities with much smaller areas, the urbanisation effect spreads across neighbouring regencies and difficult to trace with aggregated data.

[5] The Mega Rice Project was a failed programme initiated by the Indonesian Government to develop one million hectares of degraded peatland for food crop production in 1996.

[6] The transmigration programme is a population-relocation programme that moves landless people mainly from the densely populated Java Island to less populous islands of the country, e.g. Kalimantan. See e.g. Potter (2012).

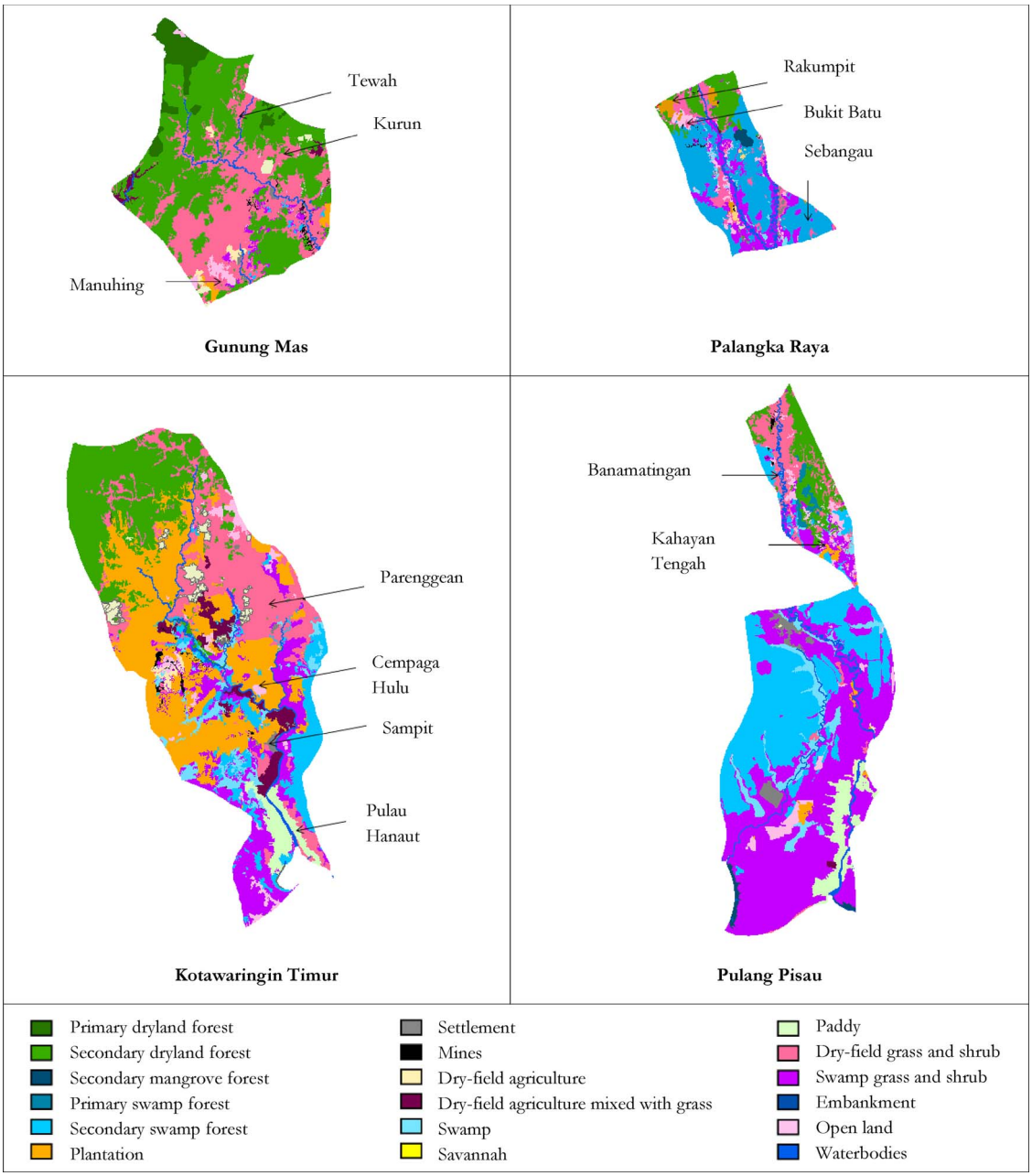

Fig. 1. Land covers of the four selected regencies in 2011 and the sub-regencies (*kecamatan*) visited to gather information from local stakeholders.
*Including housekeepers, senior citizens and students (> 15 year-old)
(Source: adapted from MoF 2011).

able to communicate with the interviewees using both the common tongue, i.e. Bahasa Indonesia, and the relevant native Dayak language.

In total, 13 sub-regencies (*kecamatan*) were visited (Fig. 1, see also Fig. S1). Group discussions were conducted in 23 villages (Table S1). In terms of geographical distribution, Kotawaringin Timur has the most villages visited (11) while Pulang Pisau has the least (3). The majority of the group discussions have 2–3 participants (mostly family members or neighbours), but some involved larger groups, e.g. 10 participants in Bapinang Hilir (Pulau Hanaut). The length of discussion also varies from 0.5 to 2 h, and sometimes followed by short field trips organised by the interviewees. Most interviewees have also non-agricultural income (e.g. mining or fishing), except the plasma farmers in Parenggean who rely solely on oil palm. Regarding industrial viewpoints, key informants from two major international oil palm companies were interviewed. One company invited the first author and his team to their plantation for field study (see Section 2.3) and group discussions with managers at different levels. In addition, 5 government officials and 7 experts with various backgrounds were interviewed (Table S2).

2.2. Estimating labour availability per regency

Labour availability was identified by the interviewees as a major factor for mobilising ULC land in the four regencies. However, previous literature has not investigated how local labour availability may constrain mobilising ULC land. While we focused on four regencies to identify the factors for mobilising ULC land, here we assessed all regencies in Kalimantan. This is because labour availability may also be a factor for other regencies due to Kalimantan having a rather low population density (from 25 person/km^2) compared to Java (1055 person/km^2) and Sumatra (105 person/km^2) in general (BPS, 2015,

Table 1
Key questions formulated for the interviews and group discussions.

Definition	– What land is considered "under-utilised" and/or "low carbon"? – What size is such land? What kind of soil? Who owns these lands? What are the neighbouring land covers?
Previous land-use	- Forests: Were these lands forested in the interviewee's memory? Since when were they deforested and by who? Why were these lands deforested? - Productive use: Were they being used before turning into ULC? If they are agricultural lands, what crops were planted? Why were these lands abandoned? - Regeneration: Was there any regeneration of forest? If not, why?
Present land-use	- Are these lands being used now for agriculture and at what frequency and intensity? What crops are planted, and by who?
Opportunities and barriers	– What are economic opportunities and barriers of ULC land? – What are agro-ecological opportunities and barriers of ULC land? – What are institutional opportunities and barriers of ULC land? e.g. what policies, programmes or regulations related to the ULC lands have been introduced? What are your experience with/opinions on these? – What are socio-cultural opportunities and barriers of ULC land?

numbers for 2010). As mentioned earlier, oil palm expansion is a major concern in Kalimantan and therefore we specifically chose to focus the assessment on this crop. To assess this factor, 6 steps were taken to build two scenarios, as explained next.

Firstly, the size of the labour force for each regency was estimated. The percentage of labour force per total population based on age structure has not changed much between 2008 and 2012 (BPS, 2016). For all the four provinces in Kalimantan, about 45–52% of the population were in the labour force, and 27–33% were children under 15-year-old. The rest were those considered eligible to work (i.e. > 15 year-old) but are currently not in the labour force, e.g. housekeepers, senior citizens and students. Based on the population statistics (2008–2012) reported by BPS Kalbar (2014); BPS Kalsel (2014); BPS Kalteng (2014) and BPS Kaltim (2014), the population per regency was linearly forecasted until 2030. The year 2030 was chosen because this year marks the end of the life cycle of most oil palm area in Kalimantan, which was established in the early 2000's. The situation of land-use by then will largely depend on global palm oil supply and demand. Conservatively, the percentage of labour force for all regencies in Kalimantan was assumed to be 45%, and the size of labour force per regency in 2030 was estimated by multiplying this percentage with the forecasted population as in Eq. (1). It was also assumed that 33% will be children (< 15 year-old) and the rest (> 15 year-old) will not be in the labour force.

$$\text{Labour force per regency(Lf)} = \text{Regency population} \times 45\% \quad (1)$$

One limitation is that the number of labourers in non-agricultural sectors was not known. To address this limitation, two scenarios were built in the second step. For Scenario 1, Eq. (2a) was employed, where the case of maximum labour availability was used, assuming that becoming an oil palm smallholder (with intensification) or working on an oil palm plantation is more attractive than subsistence and non-agricultural activities (e.g. mining, logging or working in the cities). For Scenario 2, the labour force diverted to non-agricultural sectors was determined by comparing the income ratio from agricultural and non-agricultural sources using data in 2013 from the household survey by BPS (2013a) as shown in Eq. (2b). The underlying assumption is that the labourers will divide their manpower in the two sectors simply based on economic considerations. For example, the higher rates of urbanisation and mining in East Kalimantan may largely distract many labourers from being available for working on oil palm plantations. This is, however, a simplification as we are unable to model factors like mobility and lifestyle that affects the choices. Naturally, this scenario will lead to a significantly lower labour availability than in Scenario 1. As the aim of this analysis is to further refine the maximal area of land that can be used for agricultural activities with oil palm as an example, we did not further divide the agricultural labour force into oil palm and non-oil palm. Also, the majority of the interviewees regard oil palm as one of the agricultural activities which they will switch to and from depending on the attractiveness.

$$\text{Labour force per regency in agricultural sector (Lt)} = \text{Lf} \quad (2a)$$

$$\text{Labour force per regency in agricultural sector (Lt)} = \text{Lf} \times \frac{\text{Income from agricultural sector}}{\text{Total household income}} \quad (2b)$$

Thirdly, for each scenario, the labourers who would already be working on existing large-scale plantations were deducted from the labour force. Budidarsono et al. (2011) estimated that the labour requirement of a plantation during a 25-year cycle ranged from 59 to 144 person-days per ha per year, depending on the age of the oil palm trees. This was translated to labour requirement factors of about 0.2–0.5 person per ha, considering 300 working days per year. Taking the average value of 0.35, this factor was multiplied with the area of large-scale plantation in each regency in 2011 to deduce the number of labourers on existing plantations (MoF, 2015; Goh et al., 2017) as in Eq. (3):

$$\text{Labourers on existing plantation (Le)} = \textit{Area of large scale plantation in each regency} \times 0.35 \quad (3)$$

Fourthly, the labour requirement for mobilising ULC land was calculated with a demonstration on oil palm. WRI (2012) provided estimates of low carbon land suitable for oil palm with elevation < 1000m, soil depth > 75 cm, soil acidity < pH 7.3, slope < 30%, water resource buffers > 100m, and conservation buffer > 1000m. These estimates, however, did not consider labour availability as a constraint to how much of ULC land may be mobilised. Labour requirement was calculated if these lands (excluding those that were already cultivated with oil palm, as calculated in Goh et al., 2017) were to be converted into oil palm plantation, by multiplying the area per regency by the labour requirement factor of 0.35 person per ha (at industrial efficiency as of the existing large-scale plantations) as in Eq. (4):

$$\text{Labour requirement (Lr)} = \text{Area of suitable land in each regency(excluding planted area)} \times 0.35 \quad (4)$$

Else

The fifth step, as shown in Eq. (5), was to calculate whether the labour force in 2030 (excluding those who would be working on existing plantations) will be enough to fulfil the new labour requirement. The step was repeated for both Scenario 1 and 2 using Lt_1 and Lt_2 as Lt in Eq. (5), respectively.

$$\text{If (Lt} - \text{Le)} > \text{Lr}$$

Table 2
Identification of factors in mobilising ULC land and specification of these factors in terms of opportunities and barriers to a specific land-use or in general by interviewees.

	Local actors perspectives (small-scale farming) on opportunities and barriers to **a specific land-use** or in **general**				Industrial **perspectives**
Regency	Gunung Mas	Kotawaringin Timur	Palangka Raya	Pulang Pisau	
Regency characteristics	Subsistence farmers with **alternative** income sources	**Integration with international** market	**Urbanisation**	Unsuitable agro-ecological **conditions**	
Economic factors					
Labour availability	General	Paddy	General	-	-
Land trading	-	General	General	-	Oil palm
Logistics	Oil palm	Paddy	General	-	-
Land fragmentation and scale	Oil palm	Oil palm	Oil palm	Oil palm	Oil palm
Profitability, flexibility and maintenance	Oil palm	Oil palm	Oil palm	Oil palm	Oil palm
Extra-local involvement and financing	Oil palm	Oil palm	Oil palm	Oil palm	Oil palm
Agro-ecological factors					
Soil quality	General	Oil palm / Paddy	General	General	Oil palm
Uncontrolled fire	Permanent crops	Permanent crops	Permanent crops	Permanent crops	-
Poor water management	-	Paddy	Paddy	-	-
Institutional factors					
Logged and locked	General	General	-	-	Oil palm
Institutional capacities	-	General	General	-	Oil palm
Cultural factors					
Land-use preference	General	Oil palm	General	General	Oil palm

Legends: Dark grey cells represent opportunities, light grey cells represent both opportunities and barriers, white cells represent barriers, and dashes represent no opinions or no issues. Note on how to read the Table: Taking the case of Gunung Mas as an example, 'labour availability' is deemed a barrier in general (for all land-uses), while 'logistics' is deemed a barrier for planting oil palm. For the latter, no other crops were mentioned by the interviewees.

Labourers available for mobilizing land suitable for oil palm (excluding existing plantation) (La) = Lr (5a)

Labour surplus (Ls)=(Lt − Le) − Lr (5b)

Non-local labourers required to fully mobilise all land suitable for oil palm (Lel) = 0 (5c)

Else

Labourers available for mobilizing land suitable for oil plam (excluding existing plantation)(La) = (Lt − Le) (5d)

Labour surplus (Ls) = 0 (5e)

Non − local labourers required to fully mobilise all land suitable for oil palm (Lel) = Lr − (Lt − Le) (5f)

Finally, the sixth step, the maximum amount of land suitable for oil palm that can be fully mobilised per regency in 2030 with forecasted labour availability in both Scenario 1 and 2 was estimated. This was done by dividing the labourers available per regency (*La*) by the labour requirement factor as in Eq. (6).

Maximum land that can be fully mobilized with local labour = La/0.35 (6)

3. Results and discussions

3.1. Definition of ULC land

The results of the interviews indicated that the interviewees, especially the local communities, do not have clear opinions on the criterion of 'low carbon'. During the interviews, it was often required to give more clarification on this criterion, including field trips to identify some low carbon sites, so that they can respond to the questions specifically referring to those types of land. This is crucial for clarification on excluding forests because the definition of 'forest' can be defined differently under different framework (e.g. land legally categorised as 'forested land' is not necessary forest and vice versa). This is also applicable to swamp land, where some respondents have insisted that degraded peatland (which is largely shown as swamp grass and shrub on the maps in Fig. 1) should also be taken into consideration. While we do not rule out the possibility that degraded peatland might be used in sustainable ways by the communities for productive purpose, its use and environmental impacts are contested. We leave this discussion out from this paper as it requires further agro-ecological investigation and it is not within the original scope to look at low carbon sites.

For the second criterion, 'under-utilisation', most respondents agreed that it is about agricultural productivity, but some have also pointed out that lands that are not being used may not be strictly considered 'under-utilised', because land should 'get some rest' from time to time before the next cycle of use (this actually refers to their culture of shifting agriculture). The latter was described as a cultural factor under section 3.2.6.

3.2. Key factors for mobilising ULC land in the four regencies

3.2.1. Overview of the key factors

The factors were broadly categorised into economic, agro-ecological, institutional and cultural factors. Within each of these categories, interviewees pointed out that a specific factor could be an opportunity and/or a barrier for specific land-use (or in general). For example, labour availability was regarded as a general barrier to all land-use in Gunung Mas, but was seen as a more specific barrier to paddy cultivation in Kotawaringin Timur due to labour competition with oil palm plantation. Table 2 summarises the key factors identified by the interviewees from the four regencies as well as by the industrial informants

on large-scale industrial oil palm establishment; more details for this classification are provided in the remainder of Section 3.

In general, all interviewees understood the two criteria proposed to define ULC land, but they also pinpointed that sometimes ULC land cannot be clearly distinguished from 'regularly' used land as land-use is dynamic and different land-uses interweave with each other. For many cases, the discussion on ULC land can thus not be isolated from the general land-use dynamics in that area.

Below, we first discuss commonalities and differences in perspectives from different actors. In the following subsections, we then discuss each of the identified factors and whether they are seen as opportunities or barriers and cross-checked with literature. References are given when the information is from the literature; all other findings are from the interviews.

Many common views were observed. For example, many interviewees, whether industrial players, independent oil palm smallholders, plasma farmers,[7] or small farmers who practise mixed-crop farming, have regarded oil palm as an economic opportunity. This reflects that at that moment there were not many other economically attractive land-use options for them. While paddy is widely grown in Indonesia (especially in Java) as the major food staple, improving food security was less a concern among the interviewees in the four regencies, except some Javanese paddy farmers in Kotawaringin Timur, who practise wet-field paddy farming, and raised their concerns that more and more paddy fields may turn into ULC land. Agro-forestry, which is highly advocated by researchers and NGOs as a suitable land-use option for future expansion on ULC land (see e.g. De Foresta and Michon, 1996; Roshetko et al., 2007), was seldom discussed by the interviewees. Some of them are aware of the concept, but they do not deem it economically attractive, as returns are lower than for oil palm production, and any added value for e.g. organic production generally does not reach them.

However, findings show that opportunities and barriers can be different from one regency to another for different land-use options. For example, labour availability was found to be a barrier by small farmers in Gunung Mas which has not experienced any significant influx of migrants, but it was mentioned as an opportunity by their counterparts in Palangka Raya due to a relatively high unemployment rate as part of recent urbanisation. Meanwhile, the industrial informants have also shared different views on certain factors. Labour availability has not been an issue for the industry (at the moment) as extra-local labourers can be introduced from other islands.

One should be noted that several factors are also applicable to all types of land. Exclusive emphasis on tackling some of these factors, specifically labour availability, logistics, and extra-local involvement and financing, may trigger unwanted land-use change. For example, bringing in people and capital into the fragmented ULC areas or building more roads to connect these areas to cities and ports may expose high carbon land surrounding the areas to the risks of carbon stock loss. Therefore, tapping opportunities of mobilising ULC land must be complementary to and integrated with other key land-use policies throughout the landscape, especially those addressing unsustainable land-use, such as Indonesia Forest Moratorium which prevent conversion of high carbon stock forests (Murdiyarso et al., 2011). Addressing these factors must be viewed as parts of the broader process of promoting sustainable land-use practices, in which an increasing proportion of agricultural activities are shifted from high carbon land to low carbon land. For example, improving institutional capacities can help not only facilitating the mobilisation of ULC land, but also strengthening the implementation of all land-use policies from a landscape perspective.

[7] Plasma schemes are outgrower schemes designed to assist small farmers by attaching them to large companies that provide technical and financial supports to them during the establishment of oil palm. Later on, they become independent growers that sell their fresh fruit bunches to the company.

3.2.2. Economic factors

3.2.2.1. Labour availability. This factor was found to strongly influence the land-use intensity of ULC land (also reported by Ananda and Herath 2003; Baumann et al., 2011). Labour scarcity was indicated as a barrier for mobilising ULC land in Kalimantan. Three phenomena were observed from the field trips: (i) labour competition between agricultural and non-agricultural activities, (ii) labour competition between different agricultural activities, and (iii) uneven labour distribution between regencies due to urbanisation. Phenomenon (i) was prominent in Gunung Mas due to income opportunities from (illegal) mining, which reduce interest in cash crop farming. Phenomenon (ii) was represented by the case observed in Pulau Hanaut (the only part in Kotawaringin Timur that still has paddy fields), where young labourers preferred to work on industrial plantations for better income instead of staying with traditional paddy farming. Consequently, agricultural land was abandoned due to lack of labourers. In contrast, phenomenon (iii) was found when comparing the general situation in most places with the trend in Rakumpit (Palangka Raya) where young people were struggling with unemployment in facing rapid urbanisation, and have no land to farm (mostly sold to outsiders). This illustrates a highly uneven labour availability across the regencies.

Overall, these findings suggest that parallel income opportunities (e.g. mining), food security (e.g. maintaining paddy production) and labourers' preference (e.g. preference to stay in an urban area) are three local factors that need to be further explored on regency-by-regency basis to better estimate the labour availability for mobilising ULC land. This factor was less of a concern by the industry as they often source their labourers from other Indonesian islands.[8] For exploratory purpose, labour availability per regency was estimated in Section 3.2 for the case of oil palm cultivation on ULC land under industrial management in all of Kalimantan to estimate how labour availability influences the mobilisation of ULC land.

3.2.2.2. Land trading. Despite uncertainties in land tenure, speculative land trading was frequently found in Kalimantan (see also Fox et al., 2009; Li 2007). In Palangka Raya, opportunities for local communities to sell their land at higher price to extra-local buyers motivated the villagers to expand further into forests, especially those located at the edges of city centre, roadsides or land that is expected to be converted to oil palm concessions. They let shrub and grass grow, and only sporadically planted rubber and fruit trees to mark their ownership (see also Potter 1997; Tyynela et al., 2002; Fairhurst et al., 2010). Many of these lands were sold to extra-local buyers who do not intend to perform agricultural activities but speculate on the land price to increase. Similar cases were also observed in the outskirts of Sampit (the capital of Kotawaringin Timur), where a large area of deforested land at the edge of the city was systematically divided into small pieces and sold to the public as a form of investment rather than for agricultural purposes. These speculation activities is in fact a significant driver of the formation of ULC land.

From the industrial perspectives, the uncertainties and confusion in land tenure have been the main barriers to obtaining a continuous area of ULC land for large-scale deployment. Multiple claims on the same pieces of lands have led to serious social conflicts, especially between private enterprises and local communities (see sub-section 'Socio-cultural factors'). Due to uncertainties in land tenure and rapid land trading, it is difficult to distinguish ULC land owned by local communities and extra-local speculators. When developing strategies for using ULC land, clarification of land ownership and the roles of different land-use actors is critical.

[8] For example, the industrial plantation visited (see Section 6.3.3) has about 74% of the staff come from the other islands.

3.2.2.3. Logistics. In all the four regencies, large areas of land along the main roads were found deforested but left unused by the local communities (or sold to extra-local speculators already), speculating that the land price will go up later. However, roads also represent entry points into modern agricultural practices, e.g. access to knowledge, fertilisers and fuels, which stimulates intensification. The case in Tewah (Gunung Mas) where farmers have given up intensification due to poor logistics and lack of access to fertilisers has supported the claim of Garrity et al. (1997); Garrity (1995) that the pathways of intensification are determined by access to fertilisers. Also in Lampuyang (Kotawaringin Timur), although many of the farmers were equipped with hand tractors, they did not have a secure and stable fuel supply due to poor logistics.[9] The logistics have been gradually upgraded in the past decades, but it still requires further improvement. Low quality roads may not be functional all the time. For example, in Gunung Mas, a large part of the regency will be isolated after heavy rain because it is too dangerous to travel on roads full with potholes. A contradictory case is Palangka Raya – where the income per hectare of land occupied for agriculture is the highest (about USD 1300/ha) among the four regencies, far higher than the other three (the second highest is Kotawaringin Timur, amounted to about 600 USD/ha) (BPS, 2013b). This is likely due to urbanisation.

These findings are in line with the literature – it was widely documented that the availability of a quality road network has effects on both deforestation and utilisation of grasslands (e.g. Laurance et al., 2015; Tomich et al., 1997). Particularly, roads constructed for logging were often followed by both local communities and migrants to expand their agricultural activities (Fox et al., 2009). This was, however, less discussed by the industrial informants as they perceived road building as part of the cost of deployment.

Since logistics is the key determinant for mobilising ULC land particularly for small farmers, spatially explicit mapping of road distribution, road quality, elevation and other factors that affect logistics is required to better evaluate land accessibility.

3.2.2.4. Land fragmentation and scale. Scale is a key economic factor for cash crops like oil palm. For industrial scale, a large continuous concession with area > 10 kha (with a 60 t FFB per hour mill) is more economically attractive compared to a small concession (with a 30 t FFB per hour mill). A senior industrial representative has emphasized the issue with large-scale investment in Central Kalimantan – most grass or shrub lands exist as small fragmented areas. Meanwhile, independent small farmers in Kalimantan, in the absence of their own mills, are highly dependent on large companies to buy their fruits.[10] While a few independent small farmers in West Kalimantan have managed to co-operatively build their own mills, 'stand-alone' mills that cater to the needs of independent farmers have not yet emerged in the four studied regencies.[11] Still, in Palangka Raya, Pulang Pisau and Kotawaringin Timur, opportunities for profitable, independent, small-scale oil palm cultivation already exist. Farmers in Pulang Pisau claimed that it was an easy business for them because middlemen will come and harvest the fruits themselves – what they needed to do was simply to grow some oil palm in their farms. Also in Gunung Mas, some independent pioneering farmers with 5–10 ha of immature oil palm have expressed their confidence in small-scale oil palm. From an environmental viewpoint, a land-use expert expressed that a lot of ULC land may also exist in patches interwoven with forests or wetlands, and may be more suitable for conservation and reforestation. Therefore, mobilisation strategies of ULC land should also be designed based on the size and continuity of the area, whether for large-scale, small-scale or conservation.

3.2.2.5. Profitability, flexibility and maintenance. Profitability, largely reflected by commodity prices, is the key factor that encourages or prohibits cash crops intensification and expansion on ULC land.[12] In Kalimantan, prices of FFB were more attractive than other cash crops to small farmers. In Manuhing and Kurun (Gunung Mas), independent small oil palm cultivations have emerged because the profitability appeared to be very attractive to them. However, the oil palm industry representatives pinpointed that this crop could be economically risky for independent small farmers because of its 'inflexibility' – it requires longer waiting time before harvest but draws large inputs at the early stage, and its price is fluctuating.

Despite the fact that other options like agro-forestry are economically less attractive, maintaining flexibility with multiple crops may be a better strategy for small actors in long term. For the case observed in Kahayan Tengah (Pulang Pisau), oil palm was generally planted as an additional crop (in combination with rubber and paddy) which generates easy income (although the productivity is relatively low compared to those under industrial management, it is still profitable). Small-scale monoculture oil palm cultivations may face the risk of being abandoned (and hence become ULC land) when palm oil price is low and small farmers cannot afford the upkeep anymore. To avoid such a situation, a long-term economically resilient land-use strategy should be adopted for mobilisation of ULC land for different land-use actors.

3.2.2.6. Extra-local involvement and financing. Intensification requires skills and investments, but small farmers (especially the indigenous groups, Dayaks) generally lack both. For example in Kahayan Tengah (Pulang Pisau), although the farmers have gained access to better seeds and fertilisers due to its proximity to the city of Palangka Raya, they lacked the cash to acquire them as well as the skills to better manage their farms. Industrial establishment of oil palm on ULC land with small farmers attached to it is one option which provides investment and skill that local communities lack. This option has received different responses from the local communities.[13] In Tewah and Manuhing (Gunung Mas), some Dayak villagers were ready to accept large-scale development in their area as they were generally land-rich, yet struggle to manage such large areas of unused land. In Sebangau (Palangka Raya), widespread negative experiences from the neighbouring areas with large-scale investment, such as empty promises and violent evictions, have reduced the willingness of the Dayak communities to be open for extra-local schemes. In Banamatingang (Pulang Pisau), the Dayak villagers have been struggling with negotiation with the large oil palm corporation – on the one hand, they hoped to bring in investment for development; on the other hand, they had little trust in the companies.[14] In many cases, claiming and selling more land to extra-local buyers was the option that provided them the quickest cash.

The industrial informants presented a different perspective – they claimed that successful plasma schemes can only be realised if a third party such as World Bank (as in the past) or local banks are willing to (co-)fund the scheme. This is, however, not in line with the legal requirement as they are obliged to provide assistance to smallholders, either 20% of their land or their profits (Potter 2016). On the government side, the officials have emphasized that their fiscal capacity is

[9] The farmers also do not receive fuel subsidies as in the transportation sector.

[10] Plasma farmers are bound to sell their fruits to the attached plantation, but independent farmers are not.

[11] Independent mills are common in Riau and Jambi.

[12] A notable comparative example is the case of cultivating *Imperata*-cassava on degraded acid upland soils in Lampung (Sumatra) reported by Purnomosidhi et al. (2005). In that case, the farmers abandoned their lands when they lost the market access due to the influence of EU quotas for imports of tapioca as fodder.

[13] With the exposure to modern lifestyle, it would be misleading to assume all the indigenous communities prefer to live in accordance with the forest. Most villagers interviewed voiced their demand for pragmatic solutions that could address poverty and improve their living standard.

[14] They complained that companies took control of their lands but did not keep their promises e.g. providing facilities and services

very limited. Worse still, the government has no clear guidelines on how the partnership should be formed, but allows the companies to determine the participation of the smallholders (see also Potter 2016).

This complex situation points towards a key aspect for mobilising ULC land – with what business models can these ULC land be effectively mobilised? This requires more local-specific assessments to search for comprehensive strategies that are suitable for individual regencies. An example of extra-local involvement is knowledge transfer and financial support from trustworthy independent sources.

3.2.3. Agro-ecological factors

3.2.3.1. Soil quality. Soil quality of ULC land in Kalimantan, which is generally lower than on the other islands (see also Mulyani and Sarwani 2013), was often regarded as a key constraint of intensification by most interviewees.[15] For small farmers who lack capital and knowledge, the solution is to expand their farms to a larger area to compensate for the low return. Under industrial management, the problem can be reduced with intensive agro-inputs and proper practices, but small farmers cannot afford this. Some industrial informants had the impression that the economic return is lower as higher agro-inputs are required. It is therefore important to account for the impact of soil quality on the economic attractiveness and feasibility of mobilising ULC land.

3.2.3.2. Uncontrolled fire. In all the studied regencies (also generally in Central Kalimantan), fire has played a major role in the formation of ULC lands. Fire usually occurs naturally in the dry season, but could also be deliberately initiated by the farmers to prepare land for new farming cycles (see Tomich et al., 1997; Murdiyarso et al., 2004). Due to uncontrolled fire, local farmers have been losing their farmlands. The worst case was observed in Rakumpit (Palangka Raya) where farmers abandoned or sold almost all of their lands because their farms were destroyed by fire. This is a vicious cycle − those abandoned lands are often occupied by *alang-alang* grass which is very vulnerable to fire. The problem was further exacerbated when the fire spreads onto peatlands, making it even more difficult to put out. Interviewees reflected that there was lack of proper plans and tools to overcome this problem. In recent years, the provincial government of Central Kalimantan has set very strict 'no burning' rules. Local communities were well-informed and deliberate large-scale burning has been reduced, but some farmers still insisted to use fire for land preparation. When designing mobilisation strategies for ULC land, risk of fire should be taken into account, and effective fire control should be given priority.

3.2.3.3. Poor water management. One key reason for abandoning paddy fields or failed harvests is poor water management. During the field trip, interviewees from paddy-oriented villages in Teluk Sampit and Pulau Hanaut (Kotawaringin Timur) and Sebangau (Palangka Raya) have specifically complained about this issue. It does not only cause low productivity due to absence of irrigation, but drought and flooding have also frequently destroyed their harvest. In Bereng Bengkel of Sebangau, the villagers have lost both their farmlands and access to the city due to frequent floods. They have to rely only on fishing and collecting forest products to support their lives. This suggests that paddy field in Kalimantan may still have a large room for intensification, and be prioritised among the ULC land for increasing food production while preventing further expansion especially on forested land.

3.2.4. Institutional factors

3.2.4.1. Logged and locked. In Central Kalimantan, vast areas of former timber concessions have turned into grassland or shrubs since the rapid logging in the past decades, but are still included in the 'forest zone', such as the cases in Tewah (Gunung Mas) and Pulau Hanaut (Kotawaringin Timur). Also, some lands remained uncultivated after deforestation although these were originally given for oil palm concessions (see also Sandker et al., 2007; Goh et al., 2017). In 2011, about 32% of the 0.7 Mha oil palm concessions in Kotawaringin Timur were uncultivated land with sparse vegetation (Goh et al., 2017). These 'logged' over lands are 'locked' up from further utilisation. Several active attempts to reclaim land ownership by the indigenous communities were observed during the field visit. For example, the villagers in Tewah have demanded the 6000 ha of former timber concession nearby their villages to be freed up for large-scale oil palm plantation. A movement at provincial level, namely '*Dayak Misik*', was initiated to obtain land rights for indigenous communities, including lands located within the 'forest zone' and concessions. Previously, a top-down effort was made by WRI and Sekala to demonstrate a land swap to unlock low carbon lands from the 'forest zone' to divert industrial oil palm development on these lands, but it was stalled due to complexity and cost of the legal process (Rosenbarger et al., 2013). In 2014, the Indonesian Ministry of Home Affairs, Forestry and Public Works, together with National Land Agency (BPN) have promulgated the 'Procedure for settlement of land tenure in the forest zone' which allows land located within the 'forest zone' to be legally claimed by individuals or communities (Kompas, 2015). This has opened a door to mobilise ULC lands which were previously locked in concessions. However, the new law does not distinguish ULC lands and forests, and no rules or guidance are given to secure sustainable land-use or prohibit land selling. Furthermore, it is unclear how to account for such land if the land is claimed by multiple actors. For example, the transmigrants in Parenggean (Kotawaringin Timur) who participated in a plasma scheme, as well as the industrial representatives, have argued that the same piece of land may be claimed multiple times by different people, i.e. the land inside concessions may be still occupied by a group of farmers although some other farmers have already 'sold' it. For this type of ULC land, sorting out the complexity of land-use rights is of the highest priority to clarify if a piece of ULC land is considered 'available' or not and to 'whom' it is available.

3.2.4.2. Institutional capacities. Interview with representatives from national government agencies revealed that the implementation of national policies at regency level has been difficult. A representative from the Ministry of Agriculture was disappointed about the fact that their policy recommendations were often not taken on by the local authorities due to lack of trust. Similar situations are also reported in literature, see e.g. Austin et al. (2014) which reported that capacity and understanding among key agencies was low. In contrast, local authorities in Kotawaringin Timur as well as the provincial government have argued that they have very limited fiscal capacity to support these policies − most programmes were usually discontinued after the first few years. The villagers pinpointed that they have to abandon their farms after the programmes were ended due to lack of financial capabilities to maintain. Many interviewees also emphasized their worries about corruption in the land and agriculture sectors. From the industrial viewpoint, the main institutional barrier to mobilising ULC lands was the rules (and enforcement) that vary from one regency to another. It is therefore necessary to take into account the capability and efficiency of regency authorities when designing regency strategies to mobilise ULC land. Especially, programmes to support the small farmers need substantial financial and technical support as well as proper monitoring.

3.2.5. Cultural factors

3.2.5.1. Land-use preference. A cultural barrier is the farmers' resistance to 'new' agricultural practices to increase production through intensification. In the four regencies, there are clear distinction in land-use practices between indigenous communities and (trans)

[15] Exceptionally, there was an area of unused land in the southern part of Kotawaringin Timur which was deemed high quality land for paddy by the interviewees. For this case, the area was economically attractive to be utilised but the factors like land tenure and labour shortage have prevented its use.

migrants (mainly Javanese). The indigenous Dayaks usually practise rotational swiddens, while Javanese (trans)migrants tend to establish paddy fields with cattle stall-fed with *alang-alang* or participate in small-scale oil palm plasma schemes. Most interviewees, including indigenous people themselves, agreed that the indigenous communities were not used to intensified farming or working on plantations. Most Dayak interviewees described that they were 'spoiled by the enormous natural resources', and thus had no motivation to intensification. This is different for (trans)migrants from Java, who have a stronger sense of land ownership (see also Purnomosidhi et al., 2005; Whitten 1987; Potter 1997). The Dayaks prefer to develop and manage agro-forestry, but they also tend to make quick money by selling their lands.[16] However, some of them also possessed a different economic vision. For example, a Dayak farmer who owns 10 ha of oil palm in Kurun (Gunung Mas) has purposely learnt the production techniques from a large-scale plantation, and hired a professional company for fertilisation. Many of his peers were also observing his results before they may follow his move. While more integration is expected in the future, many Dayaks still showed deference to intensive agriculture.[17] This is also reflected in Kotawaringin Timur: Although the regency has a relatively large supply of domestic labour, most labourers on plantations are hired from other Indonesian islands. Transmigrants have been introduced in the oil palm plasma schemes as outgrowers as seen in Parenggean (Kotawaringin Timur), but they have been entangled with serious land disputes with the indigenous people. As land-use activities in Kalimantan are largely characterised by the differences in preference and interest of different ethnic groups, ethnic distribution is a factor that should be carefully analysed. Of particular interest is whether these cultural factors provide opportunities or barriers to the mobilisation of ULC land.

3.3. Labour availability: a case study on oil palm

In section 3.1, labour availability was identified as a possible constraint for the utilisation of ULC land. In this section, we explore quantitatively for which regencies of Kalimantan this could be a serious constraint, assuming that all ULC land suitable for oil palm would actually be taken into use (see Section 2.2). Figs. 2 and 3 show the estimates of maximum labour availability in each regency in Kalimantan forecasted for the year 2030 if all lands suitable for oil palm are utilised (Panel A) and maximum land that can be mobilised as limited by local labour availability (Panel B), sorted by the area of suitable land per regency, in two different scenarios. For Scenario 1, where the whole labour force is assumed to take part in the agricultural sector, the top 20 regencies with large areas of land suitable for oil palm are mostly short of local labour (or just have merely sufficient labourers) by 2030 to fully mobilise the suitable lands, only 5 of them (Kutai Kartanegara, Seruyan, Pasir, Sambas and Tanah Bumbu) have sufficient labour availability. In Scenario 2, where part of the labour force is diverted to non-agricultural sector, the labour shortage is even more prominent, and only 3 out of the top 20 regencies have very small labour surpluses (Pasir, Sambas and Tanah Bumbu).

Labour surpluses are mostly concentrated in regencies with small areas of suitable land. Almost all of these regencies are either large cities, industrial towns like Bontang, oil mining and business centres like Balikpapan and Tarakan, or university cities like Banjar Baru.[18] But, there are also larger regencies like Pulang Pisau which is largely covered by swampland or Malinau which is largely forested. These regencies are largely unsuitable as sites for large-scale oil palm plantations, and it is questionable whether this labour force will be interested to move to the other regencies as farmers.

In Scenario 1, the maximum amount of ULC land that can be mobilised with optimistically forecasted levels of labour availability in 2030 is 11 Mha, about two-thirds of the 14 Mha of land in Kalimantan considered suitable for oil palm according to WRI (2012). Compare to 2011 (see Fig. S2), this maximum amount of ULC land that can be mobilised has increased significantly up to almost 40% due to population growth. This maximum estimate is possible only due to optimistic conditions that the new cultivation is operated at industrial efficiency (0.35 person/ha) and all the labour force is attracted to the oil palm sector. In reality, the amount of land that can be effectively mobilised could be much lower considering actual labour efficiency and preferences to participate in agricultural activities. This is illustrated in Scenario 2, where part of the labour force is diverted to non-agricultural sector. The maximum amount of ULC land that can be mobilised dropped to only slightly more than 7 Mha. If the labour requirement becomes higher due to lower efficiency (0.5 person/ha as the minimum requirement reported by Budidarsono et al., 2011), the estimate would further drop to < 7 Mha.

In 2006–2010, about 1.8 Mha of oil palm was planted in Kalimantan (0.35 Mha per year) (Gunarso et al., 2013). At this pace, it would take more than 40 years to have all the 14 Mha of ULC areas that are suitable for oil palm fully intensively used. But it should be noted that these expansions are concentrated in several regencies. For example, about 0.3 Mha of oil palm has been planted in Kotawaringin Timur in that period (about 18% of the total regency area) (Goh et al., 2017). For this regency, Fig. 2 shows that in the next decade, at maximum 0.4 Mha out of the 0.6 Mha of suitable ULC land could be planted and managed with local labourers.

This analysis shows how the labour factor limits the mobilisation of ULC land taking industrial oil palm as an example. This may vary significantly if the ULC land in a regency would be used for a combination of crops with different types of management. For example, paddy cultivation requires about 0.3 person/ha if it is managed as the lowland rice field in Java (Gérard and Ruf, 2001). The choice of land-use very much depends on market and policy drivers, as well as a range of local factors such as those identified in section 3.1. Furthermore, it should be noted that labourers remaining in agricultural sector may also remain in or be attracted to activities outside ULC land − some may be forced to stick to their farms on peatland as these are their only property, and some may prefer to keep their shifting agricultural practices.

Overall, Kalimantan has an uneven labour distribution across regencies and the current forecast is limited by uncertainties in labour mobility over time. This implies that it is important for a regency to consider multiple land-use options (which require different number of labourers) and business models (which have different levels of attractiveness and suitability for multiple land-use actors) when planning for utilising the ULC land resources.

4. Conclusion and recommendation

This study identified key factors that influence the mobilisation of ULC land based on the direct inputs of local and industrial land-use actors and cross-checking the findings with literature, taking four regencies with distinctive characteristics in Kalimantan as case studies. The interviewees identified a spectrum of factors which create various opportunities and/or barriers to them, depending on the land-use options and business models.

The importance of economic factors were widely recognised by the interviewees. For example, they generally agreed that *labour availability* is a major factor in Kalimantan due to its low population density. An additional desktop analysis on labour availability shows that labour distribution among the regencies is largely uneven, and greatly limits the actual amount of land that can be mobilised in some regencies. The discussions on agro-ecological factors are more technically oriented.

[16] The situation is different in West Kalimantan, e.g. in Sanggau where most of the oil palm smallholders are Dayaks (Potter and Badcock, 2007).

[17] In Kahayan Tengah (Pulang Pisau), the Dayak village chief pinpointed that many villagers do not believe that using better (and more costly) seeds and fertilisers will result in higher yields.

[18] Educational establishments located in the cities are indicated by the high numbers of people over age 15 but not in the work force, i.e. students.

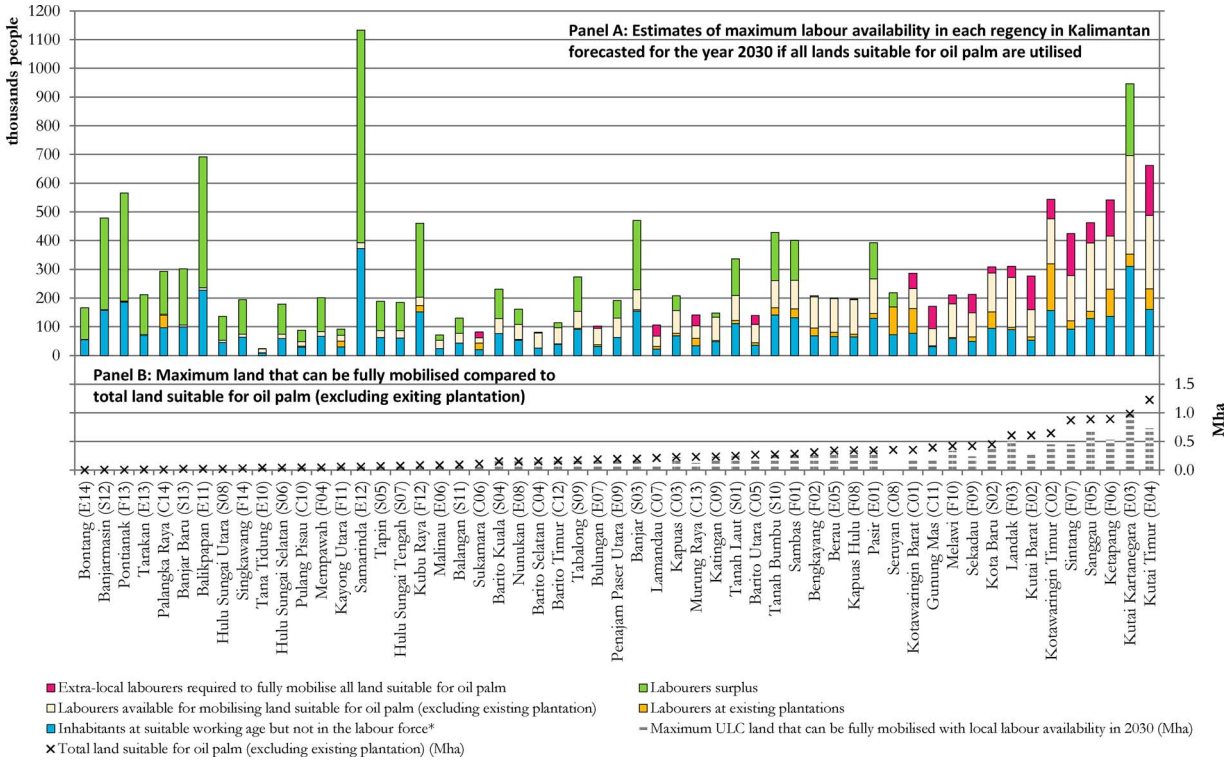

Fig. 2. Scenario 1: Estimates of maximum labour availability in each regency in Kalimantan forecasted for the year 2030 if all lands suitable for oil palm are utilised (Panel A) and maximum land that can be mobilised as limited by local labour availability (Panel B) (sorted by the area of suitable land) given none of the labour force is diverted to non-agricultural sector.

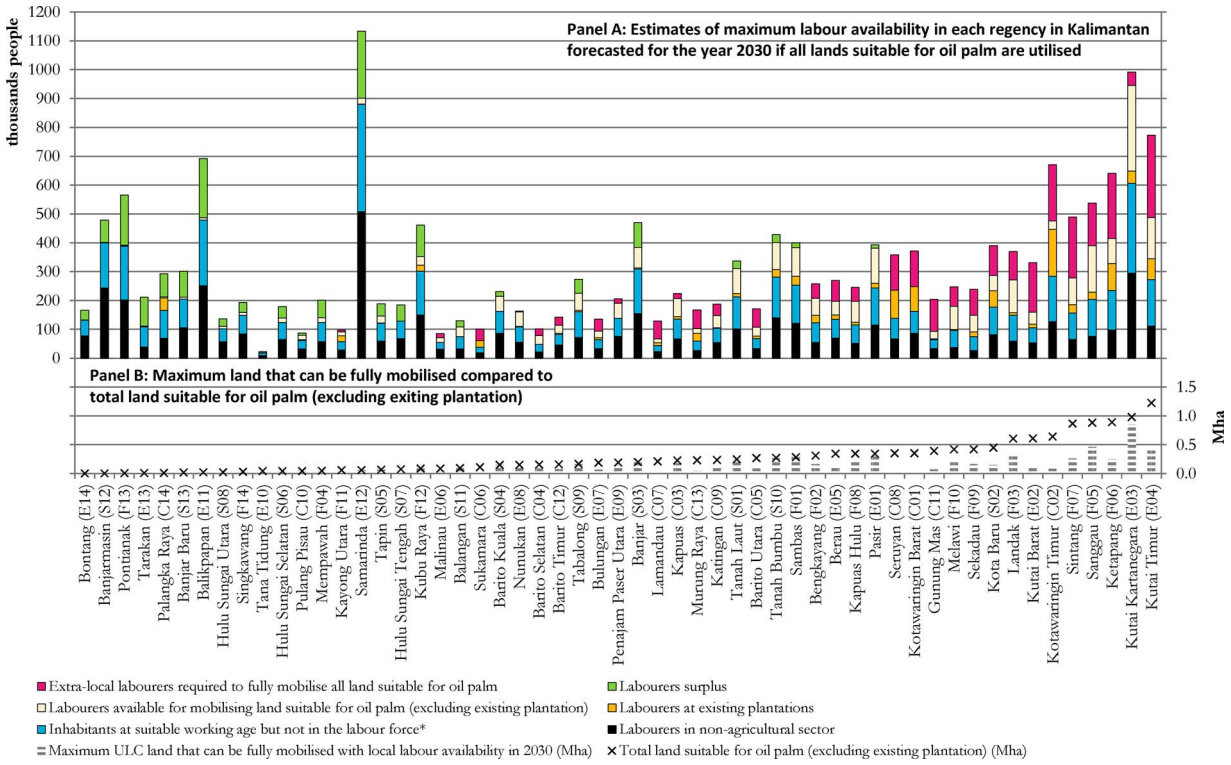

Fig. 3. Scenario 2: Estimates of maximum labour availability in each regency in Kalimantan forecasted for the year 2030 if all lands suitable for oil palm are to be utilised (Panel A) and maximum land that can be mobilised as limited by local labour availability (Panel B) (sorted by the area of suitable land) given part of the labour force is diverted to non-agricultural sector.

The barriers, such as *soil quality* and *uncontrolled fire*, were often associated with low economic attractiveness and land abandonment by the interviewees. Tailor-made strategies based on local agro-ecological conditions are required to recover the productivity of these areas. The other two categories, i.e. institutional and cultural factors, are more subtle and complex as they involve more socio-political elements across

the hierarchy of authorities. Understanding these factors requires understanding the relationships between different stakeholders and their histories. One widely discussed institutional barrier to mobilising ULC land is that a large area of ULC land has been *logged and locked* in the 'forest zone' and concessions, and is not legally available for utilisation. These two types of factors may only be tackled with approaches with certain degree of compromise that can be accepted by different stakeholders.

Given the limited number of interviews and group discussions, the findings cannot be generalised for the whole of Kalimantan, yet we deem them sufficient to identify the prominent factors of mobilising ULC land resources in the four regencies investigated. Furthermore, perspectives were taken from a diverse mix of land-use actors to cover different aspects of mobilising ULC land. Combining and cross-checking the comprehensive comments and detailed explanations from different interviewees, it became clear that many prominent trends in the regencies have been captured.

While this study was based on narrative interviews in four regencies, it is important to investigate how these factors play a role in mobilising ULC land in other regencies in Kalimantan as well, and to quantify these factors so to better understand their implications. As an example of such an analysis, this study assessed and quantified the labour availability factor for all regencies. Labour availability was found to be a major limiting factor to mobilise ULC land in many regencies with large areas of ULC land, as labour distribution is highly uneven across regencies. The result of this analysis, however, is still uncertain as it does not include the dynamics of labour mobility. Furthermore, the analyses only estimated the labour requirement if ULC land would be converted to oil palm cultivation under industrial management. Other land-use options, especially those which require less labour, may fit better into the mobilisation of ULC land in face of labour shortage. While the labour factor was quantitatively analysed, it also requires further qualitative understanding of the underlying dynamics of, in particular, labour mobility. For example, the transmigration policies in the past have triggered large fluxes of labour movement into Kalimantan. This could have major impacts on the labour availability in the regencies, but also on social and cultural conditions of the region.

In conclusion, there is a range of factors that significantly affect the mobilisation of ULC land, and they can be perceived differently by land-use actors in different regencies. As a starting point, a comprehensive local assessment of the opportunities and barriers to utilising ULC land is needed to formulate practical and realistic land-use policies on a regency level for mobilising ULC land. In other words, the policies must be acceptable to the different stakeholders especially the local communities, economically viable for continuous implementation, and minimising the risk to the environment. Instead of focusing only on a single crop or end-use, as proven by this study, this has to depart from analysing the specific conditions within individual regencies, especially considering the views of multiple land-use actors on different land-use options and business models. Therefore, it is crucial for future research to connect narrative studies on socio-economic aspects to quantitative land potential estimates which are based on environmental and agro-ecological factors.

4.1. Recommendations for future research

Future research on mobilising the ULC land resources in each regency is recommended to focus on the locally desired outcomes, which could for example be economic development, food security, conservation/afforestation or a combination of all. In addition to identifying ULC land and understanding the reasons of land under-utilisation, this leads to the search of (i) available land-use options and (ii) business models that can be employed to achieve the outcome. Opportunities and barriers associated with different land-use options and business models can be assessed by matching them with the key local factors that influence the mobilisation of ULC land. This largely depends on the preference of the local land-users, and their capability in adopting new business models. Careful considerations on local suitability, especially understanding the land-use dynamics (why is it under-utilised), and innovation in land-use planning (e.g. swapping of ULC land in the concession with high carbon stock land outside the concession) is thus required to answer these questions. This can be formulated in a matrix as shown in Table 3. For individual regencies, such a matrix can be developed through multi-stakeholder's surveys, workshops or collaboration to ensure different perspectives are taken into consideration.

In addition, the *environmental* risks accompanied by the choices of land-use option and business model have to be thoroughly examined. This paper started out on the premise that ULC land can be mobilised whilst minimising or even mitigating further carbon stock loss, but this needs to be safe-guarded. Also, other environmental impacts (e.g. provision of ecosystem services, loss of biodiversity) need to be assessed on a local level. Existing sustainability measures, such as the RSPO standards, albeit designed for other purposes instead of ULC land exploration, could be partly borrowed as a basis to mitigate environmental and partly socio-economic risks. Employing certification schemes like this as guidelines for mobilising ULC land, however, may need significant modification as they are mostly designed specifically for a crop (e.g. RSPO) or an end-market (e.g. certification schemes for biofuel). ULC land, however, can be used in various ways for different crops which serve multiple end-markets. Monitoring the environmental impact of using ULC land has to cover the entire landscape and how the different types of land-use − from small household mixed farming to industrial monoculture – can co-exist and interact.

The *social* risks, such as the risk associated with governance in terms of corruption and rent-seeking, should be carefully examined as this will undermine the benefits for the society or even trigger conflicts when large-scale investment takes place on under-utilised land that may be occupied and used in an extensive manner. This is largely linked to the legal aspect, not only in terms of the formulation of local rights, land-use rights and other regulations, but also in terms of their enforcement.

Additional guidelines in an *economic* sense are also needed for ULC land exploration to make mobilising of ULC land economically sustainable. For example, risk of project failures and land abandonment due to price changes should be taken into account. Financing schemes for shifting production onto ULC land do not exist yet, but there are conservation programmes like REDD+, which provide incentives to conserve carbon stock on land and may be an option in the future also for tree planting on ULC land.

As mobilisation of ULC land covers a range of issues and cuts across multiple sectors and scales, leveraging existing programmes, instruments and tools (such as the above-mentioned REDD+ programme) is necessary, but could also be very challenging. It is important to reframe the simple idea of 'planting a piece of ULC land with some crops' into a more complex scenario of (i) creating workable business cases (acceptable by different stakeholders, meeting local needs and conditions and economically viable), (ii) formalising the land-use scheme (particularly to protect the rights of all parties by e.g. empowering relevant authorities to monitor and enforce), (iii) providing long-term benefits for the environment, and (iv) managing it sustainably with continuity for a long period of time. Putting all relevant efforts in place requires collaboration of all relevant agencies, local communities, industries, researchers and civil society, as well as tolerance and compromise for common interests by all parties.

An example can be drawn from the current study (see Table 3 which includes some sample questions formulated based on the factors previously identified in the four regencies). Investigations on the factor 'extra-local involvement and financing' lead to the search for funding options for cash crops, food crops and/or conservation, as well as preferred business models by the funders to implement these options. A potential risk, which has happened in the past, is the possible conflicts between local and extra-local actors. In general, the cultivation of oil

Table 3
An exploratory checklist with example questions to assess opportunities and barriers of different land-use options and business models.

Overall questions for individual regencies:	What would the regency like to achieve with mobilisation of ULC land − economic development, food security, conservation or a combination of these?		
Questions to be asked for all factors	*Land-use options*: **What are the available land-use options?**	*Business models*: **What are the suitable business models to achieve the goals?**	*Risks*: **What are the short- and long-term risks of selected land-use options and business models (environmental, social and economic)?**
Economic factors			
Labour availability	How much labour is needed for different land-use options and business models? Does the regency have enough labour force? If not, is sourcing extra-local labourers a feasible option?		If extra-local labour is needed, what will be the social impacts?
Profitability, flexibility and maintenance	How profitable are different land-use and business models in both the short- and long-term? How economically resilient they are?		Will there be risks of land abandonment in the future?
Land trading	–	Who own these ULC lands? Are the owners willing to participate in the new land-use models?	Will mobilisation of ULC land trigger more deforestation for speculation?
Extra-local involvement and financing	What are the funding options for different land-use options?	What models would be preferred by these extra-local funders?	Will there be differences in opinions on land-use options or business models between local and extra-local actors?
Logistics	Is ULC land accessible? If not, is it strategic to build new infrastructure to access these lands, or is afforestation a better option?		Will the construction of new roads trigger more deforestation?
Land fragmentation and scale	What is the physical continuity of the ULC land, and what is the suitability for large- and small-scale establishment for different land −use options?		How does the use of small patches of ULC land (surrounded by forests) affect deforestation?
Agro-ecological factors			
Soil quality	What is the suitability of the soil for different land-use options?	Can the soil quality be overridden by more agro-inputs (thus higher investment) and improved management, and still be economically attractive?	Will the use of agro-inputs cause more adverse effects to the environment (e.g. pollution of rivers)?
Uncontrolled fire	Which options are more vulnerable or more likely to cause fire? What measures can be practically used to prevent fire spreading on ULC land?		How will the efforts of controlling fire within a piece of ULC land (e.g. planted with permanent crops) affect (prevention of) the fire from spreading?
Poor water management	Which option is more suitable in terms of water management, and can it be improved?	What is the effectiveness of water management of different business models?	Will the management of water reduce/increase adverse effects to the environment?
Institutional factors			
Logged and locked	How to utilise the ULC land in different types of concession previously granted (e.g. oil palm or timber planting)? How to sort out the complexity of concessions and land ownership for the piece of ULC land of interest?		Will the land-use rights of local communities be affected?
Institutional capacities	Do the regency authorities have sufficient capacity (financial and human resources) to execute the land-use policies?		How to avoid projects failures due to serious corruption when extra-local funding is not properly monitored?
Cultural factors			
Land-use preference	What are the preferred land-use options and business models for local people? Are they willing to adapt to new land-use models?		Will the new land-use models bring disadvantages to the local communities?

palm attracts the most extra-local investment as it provides the highest economic returns. However, until now it has been dominated by large-scale deployment, and only a small amount of financial support was given to plasma farmers. Other major crops, i.e. rubber and paddy, are dominated by independent smallholdings, but financing channels are missing for intensification and expansion on ULC land. Other options, such as agroforestry and carbon credit programmes, are currently lacking financial support. If a regency aims to have a more balanced development, it is likely that extra-local financing for small farmers as well as conservation programmes are necessary.

In summary, a better understanding of the multiple local factors and whether they are considered opportunities or barriers for mobilising ULC land resources in a specific setting can help to provide more accurate estimates of the ULC land resources that can be mobilised and can serve as a starting point for more informed decision-making on future land-use. Comparing the pros and cons of different land-use option and business model helps the individual regencies to capture the benefits while avoiding adverse effects in environmental and socio-economic aspects.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landusepol.2017.10.016.

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